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POLLUTION CONTROL COUNCIL, PACIFIC NORTHWEST AREA. WATER QUALITY OBJECTIVES

Federal Water Pollution Control Administration
Portland, Oregon

November 1966

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WATER QUALITY OBJECTIVES

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POLLUTION CONTROL COUNCIL

POLLUTION CONTROL COUNCIL

PACIFIC NORTHWEST AREA

November 1966

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POLLUTION CONTROL COUNCIL

PACIFIC NORTHWEST AREA

November 1966

WATER QUALITY OBJECTIVES

Prepared by:

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Original Objectives 1952
Reviewed and Readopted 1959
Reviewed and Revised 1965
Reviewed and Revised June 1966
Reviewed and Readopted November 1966

II

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PACIFIC NORTHWEST AREA

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PREFACE

WATER QUALITY OBJECTIVES

The Pacific Northwest is presently in an enviable position in regard to its water resources. Sufficient water of generally high quality prevails in most river basins throughout the area. Water is intimately tied in with the health, welfare, and pleasure of its citizens, and with the whole economic structure of the area, to such an extent as to make high water quality objectives not only desirable, but imperative.

A similar position was held by many areas of this country during the past years. The development of these areas without regard to the implications of pollution has resulted in the loss of many industrial waterways and streams for any use except the disposal of sewage and wastes. The water essential to growth and to effective living has been dissipated by carelessness and lack of foresight. Water is a factor which can well limit the development of all areas of the country; and, therefore, water pollution control in the Pacific Northwest becomes a conservation and prevention program. Certainly we in the Pacific Northwest should profit by the mistakes of others and establish high objectives for the waters of the area and apply such objectives with judgment and especially with a view to future needs.

To this end, the Pollution Control Council declares it to be the policy of the Northwest drainage basins to:

1. Encourage and promote programs for the preservation of surface and ground waters and the restoration of these waters to the best possible condition consistent with the public health and welfare; the propagation and protection of fish, aquatic life, and wildlife; and the recreational, agricultural, and industrial needs of the area;

2. Insure that the waters of those basins that have not yet been adversely affected by municipal, agricultural, or industrial development and, therefore, are of highest possible quality, be preserved in the best condition consistent with reasonable and beneficial future development;

3. Restore those waters that now exist at levels of quality below that which is necessary and desirable for the best interests of the people, to conditions permitting increased beneficial uses by the people of the area.

In furtherance of this policy, the members of the Pollution Control Council will be concerned with municipal, industrial, and agricultural waste waters as well as with water management and related land management practices which tend to adversely influence water quality.

With these considerations, the Council recommends these revised objectives of water quality.

INTRODUCTION

How good is this water? How bad is that water? Will other uses be affected if this treated waste is discharged to this stream? These wastes have been going in here for twenty years and haven't hurt anyone; why do we have to stop now? Pollution control personnel are making decisions daily on these and similar questions. In the Pacific Northwest area many of these decisions had as their basis the Water Quality Objectives and Minimum Treatment Requirements promulgated in 1952 by the Pollution Control Council. It is the basic purpose of this report to set forth updated and revised water quality objectives which can be used as bases for decision-making.

The revised Water Quality Objectives are presented in a tabular format similar to the original objectives table, which is appended for reference purposes. The tabular section has been strengthened by narrative discussions which are keyed to the table by water use letters (A through G) and water quality parameters (1 through 12). This system, for example, makes it easy to refer to square F-3 in discussing the pH of agricultural water supply. The A-G designations are not intended to rank the uses in terms of best use. This depends on the stream or section of stream involved and on the uses to which that section is best suited.

The objectives as used in this report are rules, tests, or guides useful for making decisions regarding water quality. Objectives of water quality are a collection of the best available information relating quality parameters to specific uses. They have no legal authority, but will serve as a guide for setting standards which carry legal authority. Constant surveillance of new technology and new uses must be maintained to keep these objectives flexible and useful.

It is recognized that this is a brief resume of all of the possible quality parameters and that many items are apparently overlooked. For more detailed criteria on specific contaminants, a list of references is attached at the end of this report. Reference 2* is especially valuable and lends itself well to specialized problems.

This report has been influenced to some extent by the provisions of the Federal Water Quality Act of 1965, which stipulates that states must adopt standards on interstate waters within a specified period of time or the Federal Water Pollution Control Administration will set the standards. The policy of the Pollution Control Council and the objectives contained herein appear to agree closely with the purpose and intent of the Federal Act and should therefore prove useful as a basis for the required standards.

In the preparation of these objectives, help was solicited from State and Federal water pollution control agencies, fish and wildlife groups, universities, water resources agencies, industries, and agriculture. The response was fairly good so that the objectives represent a reasonably good consensus.

* Water Quality Criteria, 2nd Ed., McKee and Wolf, Publication 3A, State Water Quality Control Board, Sacramento, California, 1963.

GENERAL DISCUSSION

The beneficial uses of domestic water supply, water-based recreation, growth and propagation of aquatic life, agricultural water supply, and industrial water supply are affected by natural variations and by man's use of the water. Each successive use leaves the water less clean for the next user unless extreme measures are taken to remove all material added by the use. Water quality objectives are aimed at protecting the downstream user by prescribing some rules that will keep the used water in the best possible condition for his use. These rules have changed as concern has progressed from erosion products through nutrient addition to pesticide impact. Bacteriological parameters have progressed from emphasis on MPN, using fermentation tube techniques, to membrane filter methods for determination of coliform group, fecal coliforms, and fecal streptococci. Progress is being made in the study of probable viral contaminants. Biological studies are under way to provide indicators of biological activity associated with varying degrees of pollution or nutrient enrichment. Natural seasonal and geographical variations in water quality may be sufficient to impair usage requirements. From the foregoing, it is apparent that protection of downstream uses is closely allied to preventing the entry of polluting materials over and above those naturally occurring. The objectives are designed to define water quality conditions that are necessary to maintain each use so that effluents which degrade the waters below these conditions can be excluded from the waters.

Some of the terms used in these objectives are described in the following glossary to provide a common base for the table and discussion material.

GLOSSARY

Objective

Rule, test, guide, aim or goal useful for making decisions regarding water quality parameters related to specific uses.

Coliform Group

The coliform group includes all of the aerobic and facultative anaerobic, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35° C. (This designation is equivalent to the older terms "B-*coli* group" and "*coli*-*aerogenes* group.")

MPN

The most probable number of coliform group organisms per 100 ml as determined by multiple-tube fermentation technique.

MF

Membrane filter technique for determining coliform group concentrations.

Coliform Group Average

The arithmetic mean of a representative number of samples, using MPN or an equivalent MF procedure.

JTU

Jackson Turbidity Units are readings from a standard Jackson Candle turbidimeter. They are based on the light path through a suspension which causes the image of a flame of a standard candle to disappear.

True Color

Color of the water from which turbidity has been removed, based on a unit of color being that produced by 1 mg/l platinum in the form of the chloroplatinate ion.

Sediment

Inorganic or organic particles originating from weathering, chemical precipitation, or biologic activity; and transported, suspended, or deposited by water, air, ice, gravity, organisms, or combinations thereof.

Toxic Matter

Both organic and inorganic constituents may be toxic to people or to the life in the streams. These toxicants often are not amenable to direct testing and require bioassay for determination of effects.

LC_{50}

Lethal concentration dose for 50% of the test organisms.

Primary Treatment

The removal of settleable, suspended, and floatable solids from waste water by the application of mechanical and/or gravitational forces. In primary treatment, agitation, aeration, or addition of chemicals may be used to enhance flocculation and increase efficiency of separation of the solids. In primary treatment, unit processes such as sedimentation, flotation, screening, centrifugal action, vacuum filtration, dissolved air flotation, and others designed to remove settleable, suspended, and floating solids have been used. Generally, a reduction in dissolved or colloidal solids will also be obtained in primary treatment, but this effect is incidental and not the planned purpose of primary treatment.

Secondary Treatment

The removal of dissolved and colloidal materials that in their unaltered state, as found in waste water, are not amenable to separation through the application of mechanical means and/or gravitational forces. Secondary treatment is generally accomplished through unit processes such as bio-absorption, biological oxidation, wet combustion, other chemical reactions, adsorption on surface-active media, change of phase, or other processes that result in the removal of colloidal and dissolved solids from waste waters.

Advanced Waste Treatment, Tertiary Treatment, or Reclamation of Waste Waters

These terms have implication with respect to the degree of removal of impurities, the ultimate being the production of pure water.

Standard Methods for the Examination of Water and Waste Water (7) is the basic reference for measurement of chemical, biological, and bacteriological parameters wherever possible. The current National Shellfish Sanitation Program, Manual of Operations (12) is used for shellfish areas. For some of the

more exotic pollutants such as pesticides, combinations of Federal Food and Drug Administration tolerances and observed toxicological data prove valuable for setting objectives.

Because these objectives are water quality objectives, treatment requirements have been left to the discretion of the pollution control authority. It is well to point out, however, that these objectives are designed to help keep high quality water in the Pacific Northwest. To achieve high quality water, no one can have a right to pollute; streams cannot be used for transporting wastes; all wastes must be treated to reduce solids, organic materials, nutrients, or other material to levels that are acceptable for downstream uses. This implies that minimum treatment of primary and secondary is necessary for nearly every stream in the Pacific Northwest.

DISCUSSION OF TABLE

Narrative descriptions in this discussion are designed to supplement, explain, and bolster the numerical and descriptive notations in the tabular format. For each of the water uses (A-G) listed on the table, the narration contains a general statement and parameter discussions (1-12).

A. Raw water objectives for domestic water supply without treatment other than simple chlorination or disinfection and removal of naturally present impurities.

General

Natural waters from protected watersheds can be used safely with proper chlorination if special care is taken in the watershed to exclude human sources of bacterial and viral contamination, and if the turbidity and organic matter that make chlorination less effective are controlled. Selective alternate diversion facilities, large storage reservoirs, and auxiliary sources should be used to the maximum extent to overcome short natural turbid runoff problems. Positive control of the human activities in the drainage basin shall be available.

A-1 Organisms of the Coliform Group

Natural waters in this area uncontaminated by human activity will normally have an average coliform MPN of less than 50. Isolated watersheds have been effective for over 60 years in producing a good grade of water where short, flash turbidity peaks are prepared for by selective diversion, storage, etc. The significance of MPN should be correlated with a sanitary survey as to origin. Therefore, the MPN or equivalent MF counts shall apply where evidence demonstrates that the coliform present may be associated with fecal sources. Samples from isolated watersheds where the stream is slow flowing and wildlife is relatively abundant may have average monthly MPN's above 50 during summer warm-water periods. To properly monitor raw water quality where chlorination alone is used, at least 20% of the number of samples required for finished water should be run on raw water as additional sanitary survey samples.

A-2 Dissolved Oxygen

DO is a valuable indicator of overall water quality for a surface water supply. Good quality surface waters should remain very close to saturation with oxygen. Departures from 100% saturation are a measure of oxygen-consuming impurities or of oxygen-producing biological activity. Abnormally low DO indicates the presence of excessive quantities of wastes having a high biochemical or chemical oxygen demand. Super-saturation with oxygen is an indication of excessive algal activity and nutrient enrichment. DO levels outside the range 75-100% of saturation denote poor raw water quality which may require extraordinary treatment to produce a safe, high-quality finished drinking water.

The following table extracted from Standard Methods for the Examination of Water and Waste Water, 12th Edition, shows solubility of oxygen at various temperatures and chlorinities:

Table 19 - Solubility of Oxygen in Water Exposed to Water-Saturated Air*

Temp. °C	Chloride Concentration in Water - mg/l					Difference per 100 mg Chloride
	0	5,000	10,000	15,000	20,000	
	Dissolved Oxygen - mg/l					
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.016
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008

*At a total pressure of 760 mm Hg. Under any other barometric pressure, P (mm: of P', in.), the solubility, S' (mg/l), can be obtained from the corresponding value in the table by the equation:

$$S' = S \frac{P - p}{760 - p}$$

in which S is the solubility at 760 mm (29.92 in.) and p is the pressure (mm) of saturated water vapor at the temperature of the water. For elevations less than 3,000 ft. and temperatures below 25° C, p can be ignored. The equation then becomes:

$$S' = S \frac{P}{760} = S \frac{P'}{29.92}$$

Dry air is assumed to contain 20.90% oxygen. (Calculations made by Whipple and Whipple.)

A-3 Hydrogen Ion Concentration (pH)

In general, a good drinking water has a pH between 6.5 and 8.5. Low pH is normally associated with the presence of carbon dioxide, mineral and organic acids, and salts of strong acids and weak bases; and can result from the presence of acid-reacting industrial wastes, swamp waters, or dissolving of naturally occurring, acid-forming mineral salts. Low pH waters are generally corrosive to metals and are often highly colored and difficult to coagulate.

High pH is normally associated with the presence of bicarbonate and carbonate ions and sometimes with hydroxide, borate silicate, and phosphate ions. High pH values can result from alkaline-reacting industrial wastes, intense algal activity, and dissolution of naturally occurring alkaline salts. High pH waters are generally hard, deposit-forming, and corrosive to some metals.

A-4 Turbidity

Turbidity is an indication of the suspended matter measured by its interference with the passage of light. It is not a direct equivalent of the amount of suspended matter, since the interference is a function of the size and number of suspended particles that compose a given weight. Turbidity of water is due to the suspension in it of clay, silt, finely divided organic matter, microscopic organisms, and similar substances.

Excessive turbidities indicate inordinate fouling of a stream by natural or artificial causes. Large quantities of turbidity-causing materials impose heavy loadings on treatment facilities and, if they are organic or soluble, can impart dissolved impurities to the water with resultant deterioration of quality.

Turbidity during normal runoff should be less than 5 JTU. During short periods of time with natural turbid runoff, selective and alternate diversion, use of storage, or auxiliary sources should be used to the maximum extent to keep the water clear enough that it can be effectively disinfected at all times when it is used for a domestic water supply.

A-5 Temperature

For domestic purposes, water with a temperature below 50° F (10° C) is usually satisfactory. Water at 60° F (15° C) or higher can become objectionable. Water system operation should be controlled to keep water below 60° F whenever this is possible. Increased temperature may stimulate organic growths and intensify taste and odor problems. If natural temperatures are in excess of 60° F, no material of higher temperature should be put into the waterway.

A-6 Dissolved Inorganic Substances

The USPHS Drinking Water Standards set a limit of 500 mg/l of dissolved solids. Some natural waters in excess of this value are used as "medicinal" waters but, in general, dissolved solids above 500 mg/l cause high use of soaps and may have cathartic effects on people who are not used to the water. Natural waters in excess of 500 mg/l would have to be treated and would be classed under B-6.

A-7 Residues

Waters for this use are objectionable if any oils, floating solids, settleable solids, sludge deposits or sediments are in evidence. Even small amounts of these residues may react unfavorably with chlorine to cause objectionable tastes and odors.

A-8 Sediment

Sediment in measurable amounts falls out in reservoirs, in pipelines, or at points of use of water and therefore should be excluded where there are no treatment facilities.

A-9 Toxic or Other Deleterious Substances, Pesticides, and Related Organic and Inorganic Materials

The USPHS Drinking Water Standards list chemical substances that should not be exceeded:

Substance	Concentration in mg/l
Alkyl Benzene Sulfonate (ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon Chloroform Extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	0.7-1.2 Optimum
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (NO_3)	45.0
Phenols	0.001
Sulfate (SO_4)	250.0
Total Dissolved Solids	500.0
Zinc (Zn)	5.0

Any concentrations of substances in excess of the following listing are cause for rejection of the supply:

Substance	Concentration in mg/l
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Hexavalent) (Cr^{+6})	0.05
Cyanide (CN)	0.2
Fluoride (F)	0.7-1.2 Optimum
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

A-10 Color

Color as used here is that resulting from natural metallic ions (iron and manganese), humus and peat materials, plankton, weeds, and some industrial wastes. Effects of unusual industrial wastes with high colors would have to be individually determined on the basis of methods shown in current Standard Methods for industrial color analyses.

A-11 Radioactivity

Levels of gross radioactivity and concentrations of radionuclides should conform to current USPHS Drinking Water Standards which are established to insure that the total intake of these radionuclides from all sources is not likely to result in an intake greater than that recommended by the Federal Radiation Council. In addition, all concentrations of radionuclides should be maintained as far as possible below the maximum permissible concentrations for water from all dietary sources recommended by the International Commission of Radiological Protection for the population at large. Surveillance must be adequate to provide estimates of average levels and determine trends to insure that the intake of radionuclides from all sources does not exceed the established guides proposed for continuous intake by the general population.

A-12 Aesthetic Considerations

Wherever simple disinfection is the only treatment, the senses of sight, smell, taste, and touch are good indicators. Anything that is offensive to these senses is not acceptable in the water supply.

B. Raw water objectives for domestic water supply with treatment.

General

Although significant advances have been made in water purification, equipment, and techniques in recent years, we do not yet have all of the answers regarding the precise relationships between viruses and human diseases, and also the possible long-term effects of the so-called exotic wastes, which result from the manufacture and use of

pesticides and from certain industrial wastes. In addition, the potential for mechanical and human failure or error must always be kept in mind. For these reasons and for whatever aesthetic values that might be assignable to any given situation, the general policy of preferentially utilizing the best possible source of raw water should be followed. Adequate treatment must be imposed as an additional safeguard to insure the highest quality water and maximum protection to the public health.

"Polluted sources should be used only when other sources are economically unavailable and then only when the provision of personnel, equipment, and operating procedures can be depended upon to purify and otherwise protect the drinking water supply continuously." (USPHS Drinking Water Standards, 1962.)

B-1 Organisms of the Coliform Group

Coliform bacteria are admittedly imperfect indicators of bacteriological safety or hazard. Fecal streptococci and perhaps fecal coli to total coliforms ratios might eventually prove to be better indicators of hazardous contamination. Because of the lack of even reasonably precise standards using these newer indicators, the MPN will be continued in use for the present. The criterion of 2,000 coliforms per 100 milliliters of sample where associated with fecal sources is considered the upper limit for waters to be safely used as a source of domestic water supply with ordinary treatment. Waters ordinarily exceeding this limit should not be used unless a better source is not reasonably available. When the dry weather MPN exceeds 2,000, extraordinary precautions must be taken to ensure the continuous production and delivery of safe water.

B-2 Dissolved Oxygen

Same as A-2.

B-3 Hydrogen Ion Concentration (pH)

Same as A-3.

B-4 Turbidity

Same as A-4.

B-5 Temperature

Not only is temperature important in its own right as a quality parameter, but it influences the saturation values of solids and gases that are or can be dissolved in it, and the rates of chemical, biochemical, and biological activity such as corrosion, BOD, and growth and death of micro-organisms.

Waters with temperatures greater than 65° F are likely to support excessive biological and bacterial growths, have a flat, unpleasant taste, and be generally unappealing as a source of domestic water supply.

B-6 Dissolved Inorganic Substances

The limit of 500 mg/l of total dissolved solids as set by the USPHS Drinking Water Standards for finished water serves as a guide to the type of treatment necessary. If a treatment system cannot reduce the dissolved solids to this level, the water quality is unsatisfactory.

B-7 Residues

Oils, floating solids, suspended solids, sludge, and sediment are objectionable because they complicate and increase costs of treatment and in some cases cannot be satisfactorily removed.

B-8 Sediment

Sediment in general can be removed in water treatment procedures, but the removal is costly. Therefore, sediment should be excluded whenever possible.

B-9 Toxic or Other Deleterious Substances

Such materials are generally objectionable as it is not always possible to depend on water treatment to lower the concentrations to acceptable levels.

B-10 Color

Color for this classification has little meaning because it can be removed by treatment; however, the treatment is costly. Therefore, a limit of 15 color units has been set as the objective.

B-11 Radioactivity

The permissible levels and surveillance requirements are the same as in A-11.

B-12 Aesthetic Considerations

To be aesthetically acceptable, the raw water should contain no wastes which are offensive to the senses of sight, taste, smell, or touch. Treatment costs for removal of these materials are high when compared with conventional treatment costs.

C. Bathing, Swimming, Recreation

General

Waters used for this purpose must be aesthetically acceptable or people will avoid the areas. Any significant signs of pollutional material, whether it be sewage, industrial wastes, silt, sediment, or natural detritus, will cause rejection of the sites by many people. Waters containing uncontrolled waste discharges above or contiguous to these points of use constitute an objectionable hazard. None of the public health surveys to date have shown direct correlations between waste discharges and water-contact diseases. However, the potential exists for people to ingest water with pathogenic organisms and contract the disease through this route. Limits in these criteria have been set so that pollution will be excluded to prevent the possible development of public health problems due to water contact. Health

risks associated with swimming in sewage-polluted water appear to be associated with chance contact with intact aggregates of infected fecal material. Therefore, treatment equivalent to secondary treatment is indicated for wastes discharged to waters in this use category.

C-1 Organisms of the Coliform Group (where associated with fecal sources)

This has been a controversial issue for many years, due principally to the fact that there are insufficient scientific research and sound epidemiological data upon which to base conclusions. For this reason, the U. S. Public Health Service has not seen fit to recommend or establish standards for bathing beach water quality. Despite this limitation, many State and local agencies have promulgated bathing water standards. Most officials accept the viewpoint that, while the bacterial quality of water for bathing need not be as high as that for drinking, the water should be reasonably free of bacteria of sewage origin.

A review of State and local standards shows that coliform concentrations for acceptable bathing areas vary widely from 50 to 3,000 bacteria per 100 milliliters. The methods of expression also vary in terms of the arithmetical mean, the geometrical mean, or the median of monthly samples. In some cases, the percentage of samples that may exceed a given limit is indicated. The most widely utilized criterion is patterned after the ORSANCO objective that the arithmetical mean coliform density should not exceed 1,000 per 100 milliliters, and that this concentration should not be exceeded in more than 20% of the samples in any one month. These bacterial standards have evidently been established arbitrarily on the basis of aesthetic considerations and compliance ability. None are founded on sound epidemiological evidence that infections have resulted due to bathing in contaminated water.

From an objective point of view, two approaches have been used to assess the relationship between the bacterial quality of bathing water and the incidence of illness in swimmers as compared with non-swimmers. One approach is based upon the probability of infection--that is, the ratio of pathogens or viruses to coliform organisms and the probability that a swimmer might ingest water containing these agents and become ill. The second approach is based upon epidemiological and statistical study of populations bathing or swimming in contaminated waters as opposed to non-swimmers or those exposed to waters of excellent bacterial quality. The studies thus far have been inconclusive.

In view of the above, it is felt that additional scientific research must be carried out before a sound basis can be established for a uniform code.

C-2 Dissolved Oxygen

At DO values below 5 mg/l, ecological changes occur which start to limit production of fish, fish food, and other useful aquatic

life. There is a tendency toward slime and aquatic weed growth, which make the water less suitable for water-contact purposes.

C-3 pH

In general, no physiological problems may be expected from water contact with pH values in the range of 6.5 to 8.5.

C-4 Turbidity

Waters with turbidities exceeding 25 Jackson Turbidity Units are not good for water-contact uses for three reasons: 1) the waters are aesthetically not acceptable, 2) there is danger from unseen submerged matter, and 3) it is not safe for swimming since the swimmers cannot see the bottom or side configuration. With certain types of turbidity a lesser value may be necessary following the above line of reasoning. If natural turbidities lie above this value, no effluent shall be added which has a higher turbidity.

C-5 Temperature

This appears to be a personal factor. Some persons can stand either cold or warm waters so that no normal range appears to be practicable.

C-6 Dissolved Inorganic Substances

People swim, fish, and boat in all types of fresh and salt waters with no apparent preferences or problems. Therefore, a limitation on dissolved solids would have no meaning. Excessive mineral nutrient concentrations should be avoided, however, due to their enhancement of algal and other aquatic nuisance growths especially in fresh water lakes.

C-7 Residues

One of the most disheartening sights in a recreation area is floating debris, scum, or sludge. This is especially true when a swimmer goes to the bottom and kicks loose a raft of foul-smelling sludge that has accumulated there. Gravel operations which discharge loads of silt and muddy water also ruin the pleasures of water-contact uses. Greases, scum, and foam often accumulate on log rafts or on floating piers and become vocational hazards to workers.

C-8 Sediment

Sediment should not be in quantities that make it impossible to see into the water. There should be no interference with normal ecology of the water system.

C-9 Toxic or Other Deleterious Substances

These materials have not been shown to have any public health significance in water-contact uses, but provision should be made to keep some surveillance since they are potentially hazardous.

C-10 Color

Color above 15 true color units causes people to stay away because they cannot see into the water.

C-11 Radioactivity

The permissible levels and surveillance requirements are the same as in Part A; and, in addition, the gross radioactivity and concentrations of radionuclides accumulating in sediments and other media from the water should contribute only negligible exposure to persons coming in contact with them. Surveillance should include the determination of activity in the radionuclide-accumulating substances.

C-12 Aesthetic Considerations

It has been noted throughout the discussion of this water use that most restrictions are due to aesthetic considerations. People will shy away from any area which has floating solids, scum, excess aquatic growths, or other evidences of pollution. To allow water-contact use, it is necessary to exclude these unsightly, potentially harmful materials.

D. Growth and Propagation of Fish

General

Any attempt to establish water quality objectives for biological life is fraught with factual limitations from the beginning. For every apparent norm there is a readily available anomaly to be cited. The wisdom of experience, and knowledge from both the laboratory and field, would most certainly guide us away from setting exact quality or quantity figures which may be construed as standards. Unfortunately, actual numbers are sometimes the most descriptive means by which values can be conveyed for establishing desired conditions in an aquatic environment.

The following narrative is set forth as an attempt to clarify some of the obvious deficiencies built into the water quality objectives chart which relates water uses to water quality parameters.

The real meaning of these titles immediately generates confusion and uncertainty because any water quality considerations for such a broad array of life must be geared to that type having the narrowest tolerance range at the highest level of water purity. Thus, in practical application, the demands for certain water quality conditions must be tailored predominately to the demands of society.

D-1 Organisms of the Coliform Group

The listed MPN value of 1,000/100 ml as an upper level for aquatic life is most definitely a public health innovation for the protection of humans rather than lesser animals. Here is an area where an experienced worker should know that an MPN

finding of 1,000, or more, will very often signify that other water quality parameters and water uses may be suffering from inadequately treated sewage.

D-2 Dissolved Oxygen

The study of dissolved oxygen has probably excited the imagination and ambition of water pollution control workers more than any other water quality parameter. Saturation or absence of oxygen in water seems to make little sense unless related to aquatic life, and all research evidence supports having oxygen saturation as an optimum for higher aquatic life. Human developments make saturation impractical, perhaps impossible, in many instances.

With presently available knowledge about DO requirements, DO levels may be recommended for certain specific aquatic life needs. Dissolved oxygen needs in the Pacific Northwest region of the United States and Southwest Canada, by no matter of choice, must be geared to salmonid fishes who are the prima donnas of both physiological intolerance, migratory uniqueness, and economic importance.

Since most Pacific Northwest fishery types require a naturally high DO content at all times, there can hardly be a valid argument presented in opposition to setting an absolute low of 75% saturation. It must be remembered that any surface waters in this area which are allowed to degenerate to 75% saturation of dissolved oxygen will likewise not measure up to quality for many of the other recognized beneficial uses. A genuine need for very nearly 100% saturation of DO in spawning, hatching, and early rearing stages of salmonid fishes has been demonstrated conclusively beyond question both under laboratory and under field conditions.

D-3 pH

The ranges of pH acceptability presented herein are exceedingly impractical for use over a geographical area as large as we are attempting to consider under one heading. Natural pH ranges from 6.5 to above 10.0 are known to occur in this region, and tolerant fish species live quite comfortably at all levels. We must, therefore, establish pH criteria for individual water bodies or stream sections in question. A pH deviation allowance of 0.5 in either direction from natural occurrence has been suggested as a most workable guideline in the State of Montana. Careful consideration and application of this practice will prove reasonable, particularly near the mode of pH ranges in specific waters. It might not be wise to add another 0.5 to a pH of 10.1 or permit a further reduction of 0.5 at pH 6.5. Definite knowledge of natural water quality for specific areas should be applied in determining acceptable pH ranges.

D-4 Turbidity

It has been amply demonstrated that acute damage to adult fish by very high turbidities is minimal and reparable, provided that the period of exposure is not prolonged, notwithstanding adverse side effects such as interference with light penetration and modification of the temperature regime of the water body. The most critical period in the life history of fish as it concerns turbidity is during the incubation period of the eggs in redds. Further, nature of the turbidity is important, since plankton blooms have not been incriminated while inorganic particulate matter is damaging. The criteria chart figure of "less than 25" Jackson Turbidity Units was selected because this level seems to be the point at which turbidity becomes troublesome to sports fishermen and other recreational enthusiasts. As with other water quality parameters, turbidity tolerances in acceptable application are to be governed by a whole array of social and ecological conditions. Turbidity cannot be related to siltation, since siltation characteristics are a function of velocity, gradient, and bottom type.

D-5 Temperature

The importance of water temperature control as it applies to fish revolves about spawning of adult fish, development of embryos and young, and disease control during critical periods. No periods of life are more critical to fish than during reproduction and hot weather. The temperatures given in the chart for different fish types and for certain spawning characteristics are at the upper limits of desirability. They certainly do not apply to all waters, nor to all fish types.

D-6 Dissolved Inorganic Substances

Dissolved inorganic substances for most fishery management purposes may be limited to heavy metals in ionic form. These are specific toxic types, zinc, copper, lead, and other less common metals. Bioassay evaluation would be necessary for suspected inorganic wastes. Inorganic nutrients fall into this category and may have an important effect on the aquatic habitat in addition to the aesthetic impact on the fishermen. Hence, inorganic nutrients should be limited to less than eutrophic levels promoting problem growths of slime, algae, or higher plants.

D-7 Residues

Numerous residue types known to accumulate from wastes would make a lengthy list, but attention is directed further to harmful residues resulting from the nutrient stimulation of secondary growths. Bacterial slime, Sphaerotilus, is a classical example of secondary growth residue. Enhanced algal and water weed growths may likewise become objectionable secondary residues. Floating residues such as oil may have little effect on water quality but are definitely deleterious to waterfowl even in small quantities.

D-8 Sediment

Sediment that closes pores in the stream bottoms or that interferes with normal ecology should be excluded.

D-9 Toxic or Other Deleterious Substances

Toxic or other deleterious substances are listed in a composite grouping of materials causing many of the more subtle environmental aberrations. The effects of these are usually most accurately evaluated through sophisticated bioassays. Non-lethal effects involving tastes and odors to fish flesh, or causing avoidance reactions, would fit this category. Some overlapping is certain to develop among categories D-7 through D-11 on the chart.

Pesticides and related compounds have been studied extensively for their effects on aquatic life, but there is still much unknown about their total effect upon an aquatic ecosystem. Recent experiences and research in Oregon have centered around herbicide wastes imparting objectionable tastes and odors to the flesh of migratory fish. When we are dealing with highly toxic substances, the working philosophy must always be, "How much can we keep out of the water?" and not, "How much can we put into it?"

Oregon State University, Department of Agricultural Chemistry (16), prepared a summary table listing FDA tolerances and toxicological data for aquatic organisms. Most of the data concern fish life. In some cases, varying experimental conditions on toxicological tests cause multiple values for a particular organism. Even so, it is felt that these toxicological values are more significant than the FDA tolerances. It is believed from data available that a reasonable water quality objective would be 0.001 of the LC_{50} for the most sensitive organism on 96-hour exposure.

D-10 Color

Any color over 50 units would tend to block out sunlight and interfere with propagation of fish food organisms.

D-11 Radioactivity

Uncontrolled radioisotopes are a far-reaching concern in our nuclear age. All phases of their production and usage are rigidly regulated, so it is generally the accidental loss of dangerous types to the environment that causes alarm.

As power reactors become commonplace, both radioactive particles and thermally heated waters will require concentrated regulatory attention. Radioisotopes, like pesticides, must be studied on their individual merits and knowledge therefrom applied to specific cases or hydrological situations. Public health regulations will govern the existence of isotopes at large.

D-12 Aesthetic Considerations

Aesthetic considerations are mostly for humans who may be seeking recreational enjoyment through fishing or other water uses.

E. Shellfish Growth and Propagation

General

Shellfish have not received attention separately from fin fish in earlier guides to water quality criteria in the Pacific Northwest, and to give them a place of distinction at this time may be inviting criticism for the dearth of specific data from which criteria were developed. If this section does nothing more than create an increased awareness of the water quality needs for shellfish and their importance as marine products of commerce, it will have served its intended purpose.

In the matters of water quality criteria, shellfish biologists are almost as quiet and tight-lipped as their subjects. Individually and collectively, they would rather remain mute than proffer water quality parameters which might prove difficult to live with at a later date. Consequently, the parameters in Line E on the water quality chart are described in very general terms.

E-1 Organisms of the Coliform Group

Maximum allowable coliform bacteria levels in waters over shellfish growing grounds are set by the USPHS as a means of safeguarding public consumers from waterborne diseases which may be transmitted via shellfish. At the time of this writing, the upper MPN limit is a median of 70/100 ml, subject to certain statistical manipulations for a series of samples. Even though this method has long been employed as a guideline to the acceptance or rejection of products going into interstate shipment, there has not yet been developed a workable correlation between the incidence of coli bacteria and other pathogenic bacteria or virus types. Refined techniques are continually being sought, and it seems likely that field measurements will soon shift from coli types to the more significant, virulent fecal streptococci species.

E-2 Dissolved Oxygen

Dissolved oxygen guidelines for shellfish are based upon known productive ranges for oyster larvae and adults under laboratory conditions. Substantially greater variations in DO afield are known to exist, but how these ranges may relate to all shellfish types remains little understood. For example, the burrowing types by necessity must survive limited periods of low DO. The critical period for survival in shellfish propagation is definitely through the egg and larval stages, and all laboratory studies bearing upon the developmental stages conclude that DO saturation is the optimum condition.

E-3 pH

Proper pH in waters for shellfish production appears to be more critical than previously thought by growers and researchers. Recent studies on oyster larvae at the Oregon State University laboratory reliably demonstrate that larvae do not "lay down" calcareous shell material in waters with a pH below 7.5. With such information pertaining to a major shellfish industry, there can be no hesitancy shown in adopting pH 7.8 as the lower level of acceptance. Marine waters of the Pacific Northwest are commonly found at pH 8.3 - 8.4.

E-4 Turbidity

Turbidity levels for shellfish waters must be dealt with solely on the basis of turbidity components. The bulk of shellfish food comes from turbidity-causing plankton blooms, laced with innumerable bacterial types. These items are pumped through the shellfish body and "strained" out as food. Turbidity of inorganic, earthen origin can be exceptionally harmful to shellfish when it replaces regular food types. Mud will not substitute for food. Prolonged exposure to earthen turbidity brings about poor body condition and increased mortality rates in adults. There is strong evidence that such turbidity is likewise deleterious to free-swimming larval stages; and, in addition, it causes their premature settling to the bottom, which is lethal.

E-5 Temperature

Temperature, as a water quality parameter for shellfish, can be neither easily described nor prescribed within definite limits. There are optimum ranges to be reported, if a specific species requirement is wanted. Unusual temperature circumstances surround the propagation of shellfish and their production for edible products. Some types do not spawn except in the upper ranges of Pacific Northwest estuarine or marine water temperatures. Contrarily, if they are held at higher temperatures, their bodies persist in a watery flaccid flesh condition which is not at all salable as a palatable market product. Thus, the annual temperature fluctuation for shellfish propagation and production must necessarily range to the upper 64° - 68° F level for spawning and drop to 45° - 50° F for edible body condition. Temperature must be related to time and species. Freezing, of course, is fatal to shellfish.

E-6 Dissolved Inorganic Substances

Dissolved inorganic substances in the nature of heavy metals are especially lethal to larval shellfish types at very low concentrations. Bioassay data would be most useful in deciding the fate of inorganic wastes which are suspected of being inimical or fatal to shellfish at any life stage. The conditions of each shellfish-waste situation should be evaluated individually for safest water quality control.

E-7 Residues

The matter of waste residues being objectionable to shellfish is hardly without exception. Beyond the free swimming larval stages they live a sedentary demersal life--literally at the bottom of the sea. Even the residues of natural decay exist as a paramount threat to shellfish survival; perhaps the burying by shifting sand and associated debris is the greatest single hazard to estuarine species. These animals without means of locomotion for escape need greater protection than motile aquatic types.

E-8 Sediment

Same as D-8.

E-9 Toxic or Other Deleterious Substances

"Freedom from toxic, colored, or other deleterious substances" is a self-explanatory grouping of materials which may not readily fit with or be only partially applicable to the general water quality parameter categories. Colored wastes would probably have little or no direct effect upon a color-blind oyster, but they could completely upset food cycles through the dimming of sunlight penetration. In similar thinking, one may recall instances when wastes would cause objectionable tastes and odors in food flesh and not measurably harm the animal.

The relationship of pesticides to shellfish has in recent years created some highly complex situations of animal toxicity, and human emotion. As would be expected, the free-swimming larval forms are the first ones to show a susceptibility to pesticide poisoning. Much more research evidence is needed in this area of water pollution control. There is a growing usage of selected pesticides by oyster farmers for the eradication of noxious predators and competitors upon their oyster beds. This practice is visually effective for the prime purpose, but virtually nothing is known of secondary or cumulative effects on the environment.

Oregon State University, Department of Agricultural Chemistry (16) prepared a summary table listing FDA tolerances and toxicological data for aquatic organisms. Most of the data concern fish life. In some cases varying experimental conditions in toxicological tests cause multiple values for a particular organism. Even so, it is felt that these toxicological values are more significant than the FDA tolerances. It is believed from data available that a reasonable water quality objective would be 0.001 of the LC_{50} for the most sensitive organism on 96-hour exposure.

E-10 Color

Color above 50 units prevents light penetration and interferes with propagation of aquatic organisms.

E-11 Radioactivity

Shellfish tend to concentrate radioactive particles during the process of pumping large volumes of water through their bodies to meet food, respiration, and body waste removal needs. There are research data available in abundance on this subject. Shellfish are analyzed for radioisotope concentrations on a routine basis by the numerous State and Federal radiological monitoring programs in operation in the Pacific Northwest.

E-12 Aesthetic Considerations

Aesthetic considerations are mostly for humans who may be seeking recreational enjoyment through fishing or other water uses.

F. Agricultural Water Supply

General

The concept of setting water quality criteria for irrigation use is acceptable within general limits, but is, in fact, the reverse of actual practice. Generally, soils are selected which are deemed suitable for the production of crops with the existing water quality, quantity, climate, and location. General criteria include concentration (salinity), sodium relations (alkalinity, sodium percentage, or sodium adsorption ratio), boron concentration, and residual sodium carbonate, but are influenced greatly by water quantities, soil characteristics, and management.

Stock water criteria are not as critical in concentration as drinking water criteria for most constituents. Total salinity in excess of 10,000 mg/l has been rated as acceptable for stock-watering purposes, while small concentrations of nitrates, fluorides, selenium, and molybdenum are of concern. Of more concern are toxic algae. Although no evidence is at hand to document occurrence of infection in cattle or hogs subjected to sewage or effluent, the risk of contamination should warrant the prohibition of such practice. Some animal diseases and parasites are suspected of being transmitted by water from dairy or slaughterhouse sources and should provide enough evidence to avoid using such water as a precautionary measure or, better yet, to keep such wastes out of the watercourse.

F-1 Organisms of the Coliform Group

From the foregoing discussion, it may be concluded that high bacterial counts in water would make it undesirable for livestock watering. If contact concentration criteria for coliform organisms average less than 1,000 per 100 ml, the limits should be the same for general farm use, and less for irrigation use when fruits or vegetables are consumed raw and irrigated within thirty days prior to harvest.

F-2 Dissolved Oxygen

Some evidence of greater effectiveness of fertilizer and growth has been related to dissolved oxygen in irrigation water for some areas. With no other evidence, perhaps a nuisance-avoidance level of three mg/l should be recommended. Successful irrigation with ground water with levels of DO less than 3 mg/l or intentional heavy loading of wastes in land disposal practices has produced acceptable levels of growth.

F-3 pH

There is a wide range of pH in the natural waters of the basin. East of the Cascades there is a general alkaline level up to 8.5, while west of the Cascades the levels may range about 6.5. If the pH is shifted, the equilibrium will shift, and it may not be balanced to the natural environment; thus it appears logical to limit any change to 0.5 unit from the natural environment.

F-4 Turbidity

Turbidity, unless caused by suspended soil particles, would not apply. The closing of the pore space in the soil results in reduced infiltration rates and less efficiency of irrigation application. Deposition in head gates, canals, and laterals causes excessive maintenance costs. There is no concentration which would prohibit its use, but a reasonable concentration up to 200 JTU may be a desirable goal unless from natural causes.

F-5 Temperature

Cold waters have a physiological shock on plants and absorb thermal energy when the air and ground temperatures are greater than the applied water temperatures. A range of 60° to 70° F (15° to 21° C) is suggested, or not more than $\pm$ 10° F (5° C) departure from the mean daily air temperature, but not exceeding 90° F.

F-6 Dissolved Inorganic Substances

The acceptability of the dissolved solids concentration of water for irrigation is determined by the soils, crop, climate, quantity of water applied, and character of the dissolved constituents as discussed in the foreword. The suggested levels of specific electrical conductivity of 1,500 micromhos @ 25° C, SAR of less than 2.5, sodium percentage less than 60%, residual carbonate of less than 1.25 me/l, and boron less than 0.3 mg/l would be suitable for most soils and crops under most conditions. This does not preclude use of water with concentrations exceeding these values but, in general, less than these levels would be desirable. Although trace concentrations of heavy metals are desirable to avoid crop-demand deficiencies, there should be less than concentrations found to be toxic to the plant or undesirable in the crop or its residues. Stock watering was discussed in the foreword.

F-7 Residues

Reduced yields have been experienced when irrigation water was contaminated by petroleum products and infiltration reduced. Slimes and aquatic growths increase maintenance costs and create operational problems.

F-8 Sediment

The impact of sediment on irrigation water use depends on the size and concentration of particles and the method of application and use. Excessive wear of sprinkler nozzle heads and fittings occurs when any sediment of very fine sand (0.074 mm) or coarser size is present in the distribution system. The extent of wear by concentrations of silt-size particles is not known, but a minimal concentration of fine sediment is desirable. Settling ponds and filters will be required to precondition sediment-bearing water for sprinkler use.

Extended application of irrigation water at a suspended sediment load concentration higher than 200 mg/l tends to close pore space in the soil, thereby reducing infiltration rates, and may lower the efficiency of application. Recharge of underground basins by prolonged spreading of water that contains suspended sediment load concentrations higher than 200 mg/l tends to clog the pores and reduce the intake rate. Acceptable concentrations above minimal levels depend on the duration of use and characteristics of the soil or soil material on which the water is being applied or spread.

Water containing sediment has not been found to be injurious to livestock. However, stock consume more clear water, thereby resulting in greater gains in weight.

The effect of sediment on agricultural water facilities includes deposition in head gates, canals and laterals, irrigation reservoirs, and stock ponds. The result can be higher maintenance costs or loss of needed water storage capacity.

F-9 Toxic or Other Deleterious Substances

The toxicity of trace metals was discussed in F-7. Limits would be concentrations in amounts less than those known to have significant effect.

F-10 Color

For this use, color seldom presents any problems.

F-11 Radioactivity

In the absence of specific values, the limits set by USPHS and NCR for drinking water would apply for stock water. The effect on soils, soil organisms, and crops is not well known. Soils are a good absorbent; crops assimilate radioactive elements. Studies

of movement of elements through soils and of assimilation (and concentration) by crops have been made, using radioactive-tagged elements. Due to decay rates and absorbance, it is doubtful if there is extensive effect of radioactive materials from water on crops. Use of the crops and concentration of elements, like the ingestion of forage by dairy cattle and the appearance of radioactive nuclides in the milk, suggest that levels of radioactive material in water for crops should be set as low as drinking water standards until further investigation shows otherwise.

F-12 Aesthetic Considerations

Irrigation water should not contain any floating, suspended, or dissolved solids from domestic or industrial wastes. Levels of nutrients should be less than those causing excessive aquatic growths.

G. Industrial

General

Industrial water users are generally willing to accept for most processes, water that meets drinking water standards. Any peculiar requirements for special use such as electronic tubes, food and beverage, brewing, high pressure boilers, etc., are recognized by industry as the responsibility of the user. One characteristic which is desirable is that the concentrations of the various constituents should remain relatively constant.

The amount of water used by industry varies widely, as does the percent used for process, for plant workers, and for carrier and cooling water. With the exception of the pulp and paper industry, 75% to 95% of the water needs are for cooling. Hence, only a small portion of the water requirements for most industries must meet the more strict requirements for process use.

In the Pacific Northwest, the major demands for industrial water are for the pulp and paper and non-ferrous metal (principally aluminum) industries.

G-1 Organisms of the Coliform Group

It is believed that any industrial water with which the worker can come in contact (handling, etc.) should conform to the coliform limits for swimming and recreation.

G-2 Dissolved Oxygen

Dissolved oxygen in many cases is not desirable for process water, since it may cause corrosion or enter into chemical reactions. Since most of the water is for cooling, the oxygen content may not be applicable.

G-3 pH

The pH usually can be adjusted to desirable levels for process water. Cooling and transport preferably would be on the alkaline side of neutrality.

G-4 Turbidity

In industrial water, abrasion would be the most objectionable property of materials causing turbidity. Process water may have to be treated.

G-5 Temperature

Not especially limiting.

G-6 Dissolved Inorganic Substances

Dissolved solids in process water may have to be treated. Constant concentrations are desirable so treatment does not have to be varied.

G-7 Residues

Residues should be treated before discharge, but industry does not consider this a limiting problem because it can treat the water for almost any of its purposes.

G-8 Sediment

Sediment is expensive to remove, as well as difficult, and should be excluded at the source whenever possible.

G-9 Toxic or Other Deleterious Substances

Toxic materials in cooling and carrier water may not be critical; in process water they may require treatment.

G-10 Color

Highly colored waters tend to interfere with some industrial processes. Color is expensive to remove and should not be added if it is possible to exclude it at the source.

G-11 Radioactivity

Workers should not be subjected to exposure to radioactivity, nor should radioactivity be incorporated in the industrial product.

G-12 Aesthetic Considerations

Certainly aesthetics may be as important to an industrial worker as to a recreationist. Therefore, there should be no suspended, floating, or dissolved matter; or scums, oils, or other objectionable material in water supplies for industrial use.

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SUPERSEDED
For reference only

WATER QUALITY OBJECTIVES AND MINIMUM TREATMENT REQUIREMENTS

WATER QUALITY → / WATER USES ↓	WATER QUALITY OBJECTIVES, APPLICABLE TO RECEIVING WATERS, FOR SALT AND FRESH SURFACE WATERS AND UNDERGROUND WATERS									MINIMUM TREATMENT REQUIREMENTS FOR DOMESTIC SEWAGE
	ORGANISMS OF THE COLIFORM GROUP	FLOATING, SUSPENDED & SETTLEABLE SOLIDS & SLUDGE DEPOSITS	TASTE-OR ODOR-PRODUCING SUBSTANCES	DISSOLVED OXYGEN	pH	TOXIC, COLORED, OR OTHER DELETERIOUS SUBSTANCES	PHENOLIC COMPOUNDS	OIL	HIGH TEMPERATURE WASTES	
A WATER SUPPLY, DRINKING, CULINARY & FOOD PROCESSING WITHOUT TREATMENT OTHER THAN SIMPLE DISINFECTION AND REMOVAL OF NATURALLY PRESENT IMPURITIES	MOST PROBABLE NUMBER COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHALL AVERAGE LESS THAN 50 PER 100 ML. IN ANY MONTH	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES OR OTHER WASTES OR WHICH, AFTER REASONABLE DILUTION & MIXTURE WITH RECEIVING WATERS, INTERFERE WITH THE BEST USE OF THESE WATERS FOR THE PURPOSE INDICATED	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.5 & 8.5	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES IN SUFFICIENT AMOUNTS AS TO MAKE RECEIVING WATER UNSAFE OR UNSUITABLE FOR USE INDICATED (U.S.P.H.S. STDS.)	LESS THAN FIVE (5) PARTS PER MILLION	NONE	NOT IN SUFFICIENT QUANTITIES ALONE OR IN COMBINATION WITH OTHER WASTES TO INTERFERE WITH THE USE INDICATED	SEDIMENTATION AND EFFECTIVE DISINFECTION
B WATER SUPPLY, DRINKING, CULINARY & FOOD PROCESSING WITH TREATMENT EQUAL TO COAGULATION, SEDIMENTATION, FILTRATION, DISINFECTION AND ANY ADDITIONAL TREATMENT NECESSARY FOR REMOVING NATURALLY PRESENT IMPURITIES	M.P.N. COLIFORM BACTERIAL CONTENT WHEN ASSOCIATED WITH DOMESTIC SEWAGE IN A REPRESENTATIVE NUMBER OF SAMPLES SHOULD AVERAGE LESS THAN 2000 PER 100 ML. AND SHOULD NOT EXCEED 5000 IN MORE THAN 20 PER CENT OF SAMPLES EXAMINED IN ANY MONTH	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXTURE, WILL INCREASE THE THRESHOLD ODOR NUMBER ABOVE 24 (4)	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	SAME AS FOR USE "A" ABOVE	SAME AS FOR USE "A" ABOVE	LESS THAN FIVE (5) PARTS PER MILLION	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES AS TO MAKE RECEIVING WATER UNFIT OR UNSAFE FOR THE USE INDICATED	SAME AS FOR USE "A" ABOVE	SEDIMENTATION AND EFFECTIVE DISINFECTION
C BATHING, SWIMMING AND RECREATION NOTE: WHEN WATERS ARE USED FOR RECREATIONAL PURPOSES SUCH AS FISHING & BOATING, EXCLUSIVE OF BATHING & SWIMMING, THE NUMBER "1000" MAY BE SUBSTITUTED FOR "2400" IN STATEMENT 3 COLIFORM CONCEPTS	COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHALL AVERAGE LESS THAN 240 PER 100 ML. AND SHALL NOT EXCEED THIS NUMBER IN MORE THAN 20 PER CENT OF SAMPLES EXAMINED WHEN ASSOCIATED WITH DOMESTIC SEWAGE (SEE NOTE UNDER "C" AT LEFT)	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXTURE, WILL INTERFERE WITH THE BEST USE OF THESE WATERS FOR THE PURPOSE INDICATED	GREATER THAN FIVE (5) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE	SAME AS FOR USE "A" ABOVE	LESS THAN 25 PARTS PER BILLION OR NONE IN SUFFICIENT AMOUNTS SUCH AS TO IMPART A RESIDUAL TASTE TO RECREATIONAL OR COMMERCIAL FISH, SHELLFISH, OR OTHER AQUATIC FORMS	SAME AS FOR USE "B" ABOVE	SAME AS FOR USE "A" ABOVE	SAME AS FOR USE "A" ABOVE
D GROWTH & PROPAGATION OF FISH, SHELLFISH & OTHER AQUATIC LIFE	COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHALL NOT HAVE A MEDIAN CONCENTRATION GREATER THAN 70 PER 100 ML. IN WATERS USED FOR THE GROWTH & PROPAGATION OF SHELLFISH	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL INTERFERE WITH THE MARKETABILITY OR PALATABILITY OF RECREATIONAL OR COMMERCIAL FISH, SHELLFISH, OR OTHER EDIBLE AQUATIC FORMS	GREATER THAN SIX (6) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES TO SUFFICIENT AMOUNT OR OF SUCH CHARACTER AS TO MAKE RECEIVING WATERS UNSAFE OR UNSUITABLE FOR USE INDICATED	SAME AS FOR USE "C" ABOVE	SAME AS FOR USE "B" ABOVE	NONE IN SUFFICIENT QUANTITY AS TO BE DELETERIOUS TO OR INTERFERE WITH THE NORMAL PROPAGATION OF FISH, SHELLFISH, OR OTHER AQUATIC LIFE	SEDIMENTATION FOR ALL USES EXCEPT THOSE WHERE SUCH WATERS ARE DISINFECTED IN ACCORDANCE WITH STATEMENT 3 ABOVE
E AGRICULTURAL AND INDUSTRIAL WATER SUPPLY WITHOUT TREATMENT EXCEPT FOR THE REMOVAL OF NATURAL IMPURITIES TO MEET SPECIAL QUALITY REQUIREMENTS, OTHER THAN THOSE CLASSIFIED UNDER "A" ABOVE. NOTE: FOR AGRICULTURAL WATER SUPPLY, SALINITY AND SODIUM HAZARDS ARE DETERMINED BY ELECTRICAL CONDUCTIVITY (EC x 10^6) AND SODIUM ADSORPTION RATIO (SAR). WATERS LOW IN BOTH SALINITY AND SODIUM ARE GENERALLY SUITABLE FOR IRRIGATION PURPOSES. (SEE "CLASSIFICATION AND USE OF IRRIGATION WATERS", CIRCULAR NO. 969, U. S. DEPARTMENT OF AGRICULTURE, NOVEMBER, 1955)		SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL ADVERSELY AFFECT THE MARKETABILITY OF AGRICULTURAL OR INDUSTRIAL PRODUCE	GREATER THAN THREE (3) PARTS PER MILLION	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.0 & 9.5	SAME AS FOR USE "A" ABOVE	NONE IN SUFFICIENT QUANTITY AS TO MAKE RECEIVING WATER UNSUITABLE FOR USE INDICATED	SAME AS FOR USE "B" ABOVE	SAME AS FOR USE "A" ABOVE	SEDIMENTATION AND EFFECTIVE DISINFECTION

Adopted by
POLLUTION CONTROL COUNCIL
PACIFIC NORTHWEST AREA
May 1952

SUPERSEDED
For reference only

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POLICY OF THE PACIFIC NORTHWEST POLLUTION CONTROL COUNCIL

1. Encourage and promote programs for the preservation of surface and ground waters and the restoration of these waters to the best possible condition consistent with the public health and welfare; the propagation and protection of fish, aquatic life, and wildlife; and the recreational, agricultural, and industrial needs of the area.

2. Insure that the waters of those basins that have not yet been adversely affected by municipal, agricultural, or industrial development and, therefore, are of highest possible quality, be preserved in the best condition consistent with reasonable and beneficial future development;

3. Restore those waters that now exist at levels of quality below that which is necessary and desirable for the best interests of the people, to conditions permitting increased beneficial uses by the people of the area.

Water Quality Parameters / Water Uses	1 Organisms of the Coliform Group by MPN or equivalent MF, using a representative number of samples (where associated with fecal sources).	2 Dissolved Oxygen mg/l or % Saturation	3 pH Natural pH conditions outside this range shall be maintained without change. Induced variation less than 0.5 pH unit.	4 Turbidity - Jackson Turbidity Units = JTU (unless natural conditions lie above that range).
A. Water Supply, Drinking, Culinary & Food Processing Without treatment other than simple disinfection and removal of naturally present impurities.	Average less than 50 per 100 ml in any month.	Greater than 75% saturation.	Between 6.5 and 8.5.	Less than 5. (See narrative for discussion of natural conditions above 5.)
B. Water Supply, Drinking, Culinary & Food Processing With adequate treatment equal to coagulation, sedimentation, filtration, disinfection, and any additional treatment necessary to remove naturally present impurities.	Average less than 2,000 per 100 ml over any consecutive 30 days. Not more than 20% of samples examined during this period should exceed 2,000 per 100 ml.	Greater than 60% saturation.	Between 6.5 and 8.5.	Less than 5 above natural conditions.
C. Bathing, Swimming, Recreation	Average less than 1,000 per 100 ml with 20% of samples not to exceed 2,400 per 100 ml. Clear water lakes and upper areas of streams should average less than 240 per 100 ml and not exceed this in more than 20% of samples.	Greater than 5 mg/l.	Between 6.5 and 8.5.	Below 25 except when natural conditions lie above this figure then effluents shall not increase the turbidity.
D. Growth and Propagation of Fish and other Aquatic Life, including Waterfowl, Furbearers, and other Aquatic and Semi-Aquatic Life	Same as C-1 to protect associated recreational values.	Greater than 75% saturation at the diurnal and seasonal low. 100% saturation during spawning, hatching, and egg sac and swim-up fry stages and when water temperatures exceed 68° F (20° C) for cold-water fish and 85° F (29.5° C) for warm-water fish.	Between 6.5 and 8.5.	Less than 25 when attributable to solids resulting from other than natural origin.
E. Shellfish Growth and Propagation (Natural and Commercial Growing Areas)	Not to exceed limits specified in Manual of Recommended Practices for Sanitary Control of the Shellfish Industry, USPHS.	Greater than six (6) mg/l saturation in the larval stage. Greater than five (5) mg/l in the adult stage.	Between 7.8 and 8.5.	None of mineral origin in excess of 25 JTU.
F. Agricultural Water Supply, including Irrigation, Stock Watering, and Truck Farming	Average less than 1,000 per 100 ml with 20% of samples not to exceed 2,400 per 100 ml for livestock watering, for irrigation of crops for human consumption, and for general farm use.	Greater than 3 mg/l.	Between 6.5 and 8.5.	Numerical values are not applicable.
G. Industrial Water Supply (other than Food Processing)	The requirements of C-1 should be met whenever worker contact is required.	Greater than 5 mg/l for surface water. Not limiting except as it affects other parameters.	Between 7.0 and 8.0.	No imposed values that will interfere with established levels of treatment.

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A

WATER QUALITY OBJECTIVES

Water Quality Objectives, Applicable to Receiving Waters, for Marine and Fresh Surface Waters

November 1966

NOTES:

1. For full co... accompanyin...
2. Qualitative ... made in acc... Examination...

3	4	5	6	7	8	9
...oration of ...e propaga- ...and indus- ...l, agricul- ...ed in the ...esirable for ...people of the ... conditions ...is range shall ...ed without ...duced varia- ...than 0.5 pH unit.	Turbidity - Jackson Turbidity Units = JTU (unless natural conditions lie above that range).	Temperature °F (°C) (unless natural conditions lie outside that range).	Dissolved Inorganic Substances	Residues: Oils and Floating Solids, Sludge Deposits	Sediment	Toxic or Other ... Substances, Pes... and Related Org... Inorganic Mater...
...5 and 8.5.	Less than 5. (See narrative for discussion of natural conditions above 5.)	Below 60° F (15° C). Waste flows above 60° F adjusted to ambient receiving water temperature.	Total dissolved solids under 500 mg/l. None in addition to natural background if this value exceeds 500 mg/l.	Below normally detectable amounts.	Below normally measurable amounts in the water diverted.	Chemical consti... should conform ... current USPHS D... Water Standards ... CCE (carbon chl... extract) 0.1 m...
...5 and 8.5.	Less than 5 above natural conditions.	Below 60° F (15° C). Waste flows above 60° F adjusted to ambient receiving water temperature.	Numerical value is not applicable.	Should be below normally detectable amounts.	No imposed loads that will interfere with established levels of treatment.	Chemical consti... should conform ... current USPHS D... Water Standards.
...5 and 8.5.	Below 25 except when natural conditions lie above this figure; then effluents shall not increase the turbidity.	Numerical value is not applicable.	Numerical value is not applicable.	No visible concentrations of wood fiber, oil sludge, sewage, scum, foam, or other wastes that may adversely affect the use indicated.	Numerical values not applicable. No visible concentrations of silt.	None or below e... trations found ... public health ...
...5 and 8.5.	Less than 25 when attributable to solids resulting from other than natural origin.	Less than 68° F (20° C) for cold-water fishery; less than 85° F (29.5° C) for warm-water fishery; less than 55° F (12.8° C) during fall spawning.	Within normal ranges to avoid chronic toxicity or significant ecological change.	Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods.	No deposition which adversely affects fish spawning and habitat.	Less than acute... problem levels ... by bioassay or ... priate methods. ... 0.001 of the LC... most sensitive ... 96-hour exposur...
...5 and 8.5.	None of mineral origin in excess of 25 JTU.	Less than 68° F (20° C).	Within normal ranges to avoid chronic toxicity or significant ecological change.	No visible evidence of wastes. Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods.	No deposition which adversely affects growth and propagation.	Less than acute... problem levels ... by bioassay or ... priate methods. ... amount that ca... of flesh of edi... Pesticides 0.00... LC_{50} for the m... organism on 96-...
...5 and 8.5.	Numerical values are not applicable.	Between 60° and 70° F (15.5° and 21.2° C) for optimum growth to prevent physiological shock to plants.	Conductivity less than 1,500 micromhos at 77° F. SAR less than 2.5, sodium percentage less than 60%, residual carbonate less than 1.25 me/l, and boron less than 0.3 mg/l.	None in sufficient quantities to cause soil plugging and reduced yield of crops.	For sprinkler irrigation, water free of particles of 0.074 mm or coarser. For irrigation or water spreading, not to exceed 200 mg/l for an extended period of time.	Less than that ... deleterious to ... plants or their ... consumption by ...
...0 and 8.0.	No imposed values that will interfere with established levels of treatment.	Less than 70° F (21.2° C).	No amounts above natural conditions which will cause undue corrosion, scaling, or process problems.	No visible evidence from wastes.	No imposed loads that will interfere with established levels of treatment.	Chemical consti... be below conce... found to be of ... significance.

B

and Fresh Surface Waters

NOTES:

1. For full comprehension and justification of the objectives in this table, reference must be made to the accompanying text.

2. Qualitative and quantitative evaluation of water samples for comparison with these objectives should be made in accordance with the procedures set forth in the current edition of Standard Methods for the Examination of Water and Waste Water, published by the APHA, the AWWA, and the WPCF.

	8	9	10	11	12
ing	Sediment	Toxic or Other Deleterious Substances, Pesticides, and Related Organic and Inorganic Materials.	Color (unless natural conditions lie outside the range).	Radioactivity	Aesthetic Considerations. Wastes offensive to the senses of sight, taste, smell, or touch.
	Below normally measurable amounts in the water diverted.	Chemical constituents should conform to current USPHS Drinking Water Standards. CCE (carbon chloroform extract) 0.1 mg/l.	True color less than 15 color units.	Conform with current USPHS Drinking Water Standards.	No evidence of matter other than that from natural conditions.
	No imposed loads that will interfere with established levels of treatment.	Chemical constituents should conform to current USPHS Drinking Water Standards.	True color less than 15 color units.	Conform with current USPHS Drinking Water Standards.	No evidence of matter other than that from natural conditions.
cen- od dge, foam, s that affect ted.	Numerical values not applicable. No visible concentrations of silt.	None or below concentrations found to be of public health significance.	True color less than 15 color units.	Conform with current USPHS Drinking Water Standards.	No floating or submerged matter not attributable to natural causes. No excess nutrients that cause visible slime growths or other nuisance aquatic growths.
s or aled other thods.	No deposition which adversely affects fish spawning and habitat.	Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods. Pesticides 0.001 of the LC_{50} for the most sensitive organism on 96-hour exposure.	True color less than 50 color units.	Current USPHS Drinking Water Standards except where concentration factors of aquatic flora and fauna exceed PHS reduction factors; then MPC of radioisotopes shall be reduced below acute or chronic problem levels.	No floating or submerged matter not attributable to natural causes. No excess nutrients that cause visible slime growths or other nuisance aquatic growths. Phenolics less than amount that causes tainting of flesh of edible species.
idence ss aled other thods.	No deposition which adversely affects growth and propagation.	Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods. Less than amount that causes tainting of flesh of edible species. Pesticides 0.001 of the LC_{50} for the most sensitive organism on 96-hour exposure.	True color less than 50 color units.	Concentrations shall be less than those resulting in radionuclide concentrations in shellfish meats which exceed the recommendations of the National Shellfish Sanitation Program, Manual of Operations, USPHS.	No floating or submerged matter not attributable to natural causes. Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods.
ient cause and of	For sprinkler irrigation, water free of particles of 0.074 mm or coarser. For irrigation or water spreading, not to exceed 200 mg/l for an extended period of time.	Less than that shown to be deleterious to livestock or plants or their subsequent consumption by humans.	Not applicable.	Conform with current USPHS Drinking Water Standards.	No visible evidence of domestic, agricultural, or industrial wastes. No abnormally heavy slime or algal growths.
idence	No imposed loads that will interfere with established levels of treatment.	Chemical constituents should be below concentrations found to be of public health significance.	True color less than 50 color units.	Conform with current USPHS Drinking Water Standards.	No floating or submerged material that is not of natural origin.

C